

# PATENT COOPERATION TREATY

From the  
INTERNATIONAL SEARCHING AUTHORITY

# PCT

To:

see form PCT/ISA/220

## WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing  
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference  
see form PCT/ISA/220

**FOR FURTHER ACTION**  
See paragraph 2 below

International application No.  
PCT/RU2004/000368

International filing date (day/month/year)  
20.09.2004

Priority date (day/month/year)  
22.09.2003

International Patent Classification (IPC) or both national classification and IPC  
H05H1/54, F03H1/00, B64G1/40

Applicant  
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### 1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

### 2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

### 3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



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**WRITTEN OPINION OF THE  
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**Box No. I Basis of the opinion**

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1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.  
☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
  - a. type of material:  
☐ a sequence listing  
☐ table(s) related to the sequence listing
  - b. format of material:  
☐ in written format  
☐ in computer readable form
  - c. time of filing/furnishing:  
☐ contained in the international application as filed.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE  
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**Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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**1. Statement**

Novelty (N)	Yes: Claims	1-25
	No: Claims	
Inventive step (IS)	Yes: Claims	2,3, 9-13,15,17,21-23,25
	No: Claims	1,4-8,14,16,18-20,24
Industrial applicability (IA)	Yes: Claims	1-25
	No: Claims	

**2. Citations and explanations**

**see separate sheet**

**Re Item V.**

Reference is made to the following documents:

D1 : RU-C1-2143586

D2 : ZIEMER J K ET AL: "Scaling laws for electromagnetic pulsed plasma thrusters"  
PLASMA SOURCES, SCIENCE AND TECHNOLOGY IOP PUBLISHING UK, vol.  
10, no. 3, August 2001 (2001-08), pages 395-405, XP002352012 ISSN: 0963-0252

D3: US-A1-2003/0033797

D4: ANTROPOV N ET AL: "High efficiency ablative pulsed plasma thruster  
characteristics" THIRD INTERNATIONAL CONFERENCE ON SPACECRAFT  
PROPULSION (SP-465) ESA NOORDWIJK, NETHERLANDS, 2000, pages 509-  
516, XP008054909

1. The present application does not meet the criteria of Article 33(1) PCT, because the subject matter of claims 1, 4-8, 14, 16, 18-20, 24 does not involve an inventive step in the sense of Article 33(3)PCT.
- 1.1 Document D1, which is considered to represent the most relevant state of the art to the subject matter of claim 1, discloses (see abstract and figures - the references in parentheses applying to this document):  
a plasma pulsed accelerator comprising two electrodes (2,3), dielectric bars (5) arranged between the electrodes and made from an ablating material, a discharge channel (1) with an open end part, with discharge channel walls being defined by the surfaces of the electrodes (2,3) and of the dielectric bars (5), an energy accumulator (4), current supplies for connecting the electrodes (2,3) with the energy accumulator (4), an insulator (7) arranged between the electrodes (2,3) at the end part of the discharge channel (1) opposite to the open end part, and a discharge initiating device (8).
- 1.2 The subject-matter of independent claim 1 differs from the disclosure of D1 in that the characteristics of the external electric circuit are selected so as the ratio  $C/L$  is greater than or equal to 2, where  $C$  ( $\mu F$ ) is the electric capacity of the external electric circuit,  $L$

is the inductance of the external electric circuit (nH), with the value of L equal to or less than 100 nH.

- 1.3 The problem to be solved by the present invention may be regarded as to reduce the losses of the working ablated substance in the acceleration channel during the plasma acceleration process, in an ablation pulsed plasma accelerator (see description, page 7, lines 5-8).

- 1.4 The solution proposed by the present application consists of selecting the values of the capacitance and of the inductance of the external electric supply circuit so as to satisfy the condition " $C$  ( $\mu F$ )/ $L$  (nH) greater than or equal to 2".

- 1.5 In view of D2 the solution proposed in claim 1 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons: The working substance losses are mainly due to the discrepancy between the relatively fast process of the formation of the discharge and the relatively slow process of heating, ablating, ionizing and accelerating the substance.

The solution proposed by the present application is aimed to synchronize the processes of discharge formation and of substance ablation, by reducing the impedance mismatch between external and internal electric circuits (see description, page 7, lines 27-33). This is obtained by selecting higher capacitance values and lower inductance values for the external pulsed power supply circuit.

Actually, this appears to be a common practice in the field of the Pulsed Plasma Thrusters (see for instance D2, page 397, or D3, par. 40) in these last years. In view of D2, the use of the condition " $C$  ( $\mu F$ )/ $L$  (nH) greater than or equal to 2" is to be seen as providing the same advantages as in the present application.

The skilled person would therefore regard it as a normal option to include this feature in the pulsed plasma accelerator of claim 1, in order to solve the posed problem.

- 1.6 Independent claim 14 discloses a method for operating the pulsed plasma accelerator of claim 1, by applying a discharge voltage of at least 1 kV to the electrodes.

Actually, it appears to be a common practice in the field of the Pulsed Plasma Thrusters in these last years to apply high voltages to the discharge electrodes (see for instance D3, par. 38, or D4, page 512, left col., last paragraph).

The skilled person would therefore regard it as a normal option to include this feature in the method of operating a pulsed plasma accelerator of claim 14.

The subject-matter of claim 14 is therefore not inventive (Art. 33(3) PCT).

- 1.7 Dependent claims 4-8, 16, 18-20, 24 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

- claims 4-8, 18-20, 24: the arrangement of electrodes and ablative bars is disclosed by D1;
- claim 16: same reasons as in above par. 1.6

2. The combination of the features of dependent claims 2, 3, 9-13, 15, 17, 25 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows:

- claims 2,3,15, 17: the claimed combination of values of capacitance and inductance is not suggested by the available prior art;
- claims 9-13, 25: the geometrical details of the accelerator are not explicitly disclosed by D1.